

# Karyological studies on some taxa of the Asteraceae in Egypt

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## Abstract

Chromosomal studies have been carried out on 10 species of the Asteraceae representing four tribes in the main two subfamilies Cichorioideae and Asteroideae collected from the flora of Egypt. In this study eight new counts are presented. These studies include detailed characterization of karyological features of each species. The cytological features are obtained from chromosome number, length and criteria of the karyotype asymmetry including chromosome arm ratio, TF% (total form percent),  $A_1$  (the intrachromosomal asymmetry index) and  $A_2$  (the interchromosomal index).

## Introduction

The Asteraceae are well represented in the flora of Egypt. TÄCKHOLM (1974) reported 93 genera and 230 species distributed in different habitats of the country (HASSIB 1950), whereas EL-HADIDI & FAYED (1995) reported 92 genera and 226 species. The family is also represented in the weeds of Egypt by 28 species (BOULOS & EL-HADIDI 1989).

The cytological criteria in the Asteraceae show considerable variations. Two contradicting views have been proposed with regard to the basic chromosome number in the family. SOLBRIG (1978) noted that  $x=9$  is the most common basic number and proposed it as the model number of the family. However, MEHRA (1977) proposed  $x=5$  as the basic number in the family. In 1996 KAMEL reported chromosome counts from 47 species of Egyptian Asteraceae and also considered  $x=5$  the ancestral number for the whole family. He suggested that the higher numbers could have been derived from polyploidy cycles and aneuploid variations.

In the present study, chromosome numbers and detailed karyotype features of 10 Egyptian species of the Asteraceae representing four tribes in the main two subfamilies Cichorioideae and Asteroideae are reported.

### Materials and Methods

Materials of 10 species belonging to the family Asteraceae were collected from their natural habitats. The studied species and the localities from which they were collected are given in Table 11. Vouchers of the collections are preserved in the herbarium of the Biological Sciences and Geology Department, Faculty of Education, Ain Shams University, Cairo (Egypt).

Cytological preparations were carried out on root tips obtained from seeds germinated on sterile moist filter papers in Petri dishes at 15-20°C. Roots were pretreated with 0.05% colchicine solution for 3-4 hrs. and fixed in Carnoy for 24 hrs. Cytological preparations were made using the Feulgen squash method and well-spread c-metaphase chromosomes were photographed from temporary preparations at a magnification of 2000 ×. Slides of the original karyotypes are also preserved in the Laboratory of Cytogenetics of the same department.

A karyogram for each species was constructed by arranging the chromosomes in homologous pairs by order of their length and arm ratio as measured from the photographic prints. The number of chromosome types was determined as described by LEVAN et al. (1965). Measurements of chromosome lengths were taken on the same photographs of the karyogram. Karyograms are based on one plate only.

The variation in chromosome length (MCL) and chromosome arm ratio (MAR) within the karyotype has been estimated by calculating the standard error (SE) of these parameters. Karyotype asymmetry deduced from the ratio between the short arms of the chromosomes and their total length was expressed as total form percent (TF%) as proposed by HUZIWARA (1962). Karyotype asymmetry expressed by the ratio between the chromosome arms has been also estimated as the intrachromosomal asymmetry index ( $A_1$ ) as suggested by ROMERO ZARCO (1986). The value of  $A_1$  is framed as to be close to zero if all chromosomes are metacentric and near to one if all chromosomes are telocentric. Karyotype asymmetry due to the ratio between size of different chromosomes has been also estimated as the interchromosomal asymmetry ( $A_2$ ) using PEARSON'S dispersion coefficient, that is the ratio between the standard deviation and the mean chromosome length (ROMERO ZARCO 1986).

The existence of previous chromosome counts for the studied species has been verified in the index of plant chromosome numbers by FEDOROV (1969), GOLDBLATT (1981, 1984, 1985, 1988) and GOLDBLATT & JOHNSON (1990, 1991, 1994, 1996).

## Results

The summary of the cytological features of the investigated species is shown in Table 11 and the karyotypes are illustrated in Fig. 1.

### Subfamily: Cichorioideae

### Tribe: Cardueae

#### *1 - Carduus pycnocephalus L.*

The examined material of this species was found to be hexaploid with a somatic chromosome number of  $2n=54$  and basic number of  $x=9$ . The karyotype is comprised of metacentric chromosomes in six groups. The chromosomes are short (MCL= $1.34 \pm 14 \mu\text{m}$ ), the MAR is  $1.30 \pm 0.02$  and TF% is 43.64. The symmetry of the karyotype is also indicated by the values of  $A_1$  (0.23) and  $A_2$  (0.31). Detailed measurements of this species are presented in Table 1.

**Table 1.** Measurements of somatic chromosomes of *Carduus pycnocephalus L.*

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	2.15	17.77	0.95	1.20	1.26	10.75	m
2	1.72	14.21	0.77	0.95	1.23	10.49	m
3	1.55	12.81	0.68	0.87	1.28	10.92	m
4	1.44	11.90	0.63	0.81	1.29	11.01	m
5	1.32	10.91	0.56	0.76	1.36	11.60	m
6	1.07	8.84	0.48	0.59	1.23	10.49	m
7	0.99	8.18	0.43	0.56	1.30	11.09	m
8	0.98	8.10	0.41	0.57	1.39	11.86	m
9	0.88	7.27	0.37	0.51	1.38	11.77	m
<b>Total</b>	12.10	99.99	5.28	6.82	11.72	99.98	--
<b>Mean</b>	1.34	--	0.58	0.76	1.30	--	--
<b><math>\pm</math> SE</b>	$\pm$ 0.14	--	$\pm$ 0.06	$\pm$ 0.08	$\pm$ 0.02	--	--

**Tribe: Lactuceae**

**2 - *Garhadiolus hedynois* (FISCH. et MEY.) JAUB. et SP.**

This species has a somatic chromosome number of  $2n=12$  in 6 homologous pairs. The karyotype consists of 2m and 4sm chromosome pairs. The MCL is  $2.99 \pm 0.23 \mu\text{m}$ , the MAR is  $2.07 \pm 0.29$ , the TF% is 34.00, the  $A_1$  is 0.46 and the  $A_2$  is 0.19. The detailed measurements of this species are found in Table 2.

**Table 2. Measurements of somatic chromosomes of *Garhadiolus hedynois* (FISH. et MEY.) JAUB. et Sp.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	3.75	20.94	1.63	2.12	1.30	10.46	m
2	3.41	19.04	1.07	2.34	2.19	17.62	sm
3	3.00	16.75	0.80	2.20	2.75	22.12	sm
4	2.95	16.47	0.75	2.20	2.93	23.57	sm
5	2.60	14.52	0.87	1.73	1.99	16.01	sm
6	2.20	12.28	0.97	1.23	1.27	10.22	m
<b>Total</b>	17.91	100.00	6.09	11.82	12.43	100.00	--
<b>Mean</b>	2.99	--	0.02	1.97	2.07	--	--
<b><math>\pm</math> SE</b>	$\pm$ 0.23	--	$\pm$ 0.13	$\pm$ 0.17	$\pm$ 0.29	--	--

### 3 - *Picris damascena* BOISS. et GAILL.

A somatic chromosome number of  $2n=10$  in only five homologous pairs was recorded in this species. The karyotype consists of 1m and 4sm chromosome pairs. The MCL is  $2.67 \pm 0.24 \mu\text{m}$ , the MAR is  $1.84 \pm 0.08$ , the TF% is 35.53,  $A_1$  is 0.45 and  $A_2$  is 0.20. Detailed chromosome measurements are presented in Table 3.

**Table 3. Measurements of somatic chromosomes of *Picris damascena* BOISS. et GAILL.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	3.40	25.49	1.34	2.06	1.54	16.72	m
2	2.78	20.84	0.94	1.84	1.96	21.28	sm
3	2.70	20.24	0.90	1.80	2.00	21.72	sm
4	2.54	19.04	0.88	1.66	1.89	20.52	sm
5	1.92	14.39	0.68	1.24	1.82	19.76	sm
<b>Total</b>	13.34	100.00	4.74	8.60	9.21	100.00	--
<b>Mean</b>	2.67	--	0.95	1.72	1.84	--	--
<b>± SE</b>	± 0.24	--	± 0.11	± 0.14	± 0.08	--	--

**4 - *Thrinicia tripolitana* SCH.-BR.**

The examined material of this species has only  $2n=8$  and  $x=4$ . The karyotype is comprised of 1m and 3sm pairs. The MCL is  $1.90 \pm 0.16 \mu\text{m}$  and the MAR is  $1.89 \pm 0.29$ . The asymmetry of the karyotype is reflected by the values of TF%(35.00),  $A_1$  (0.42) and  $A_2$  (0.17). Detailed measurements are presented in Table 4.

**Table 4. Measurements of somatic chromosomes of *Thrinicia tripolitana* SCH.-BR.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	2.36	31.05	0.68	1.68	2.47	32.63	sm
2	1.90	25.00	0.60	1.30	2.17	28.67	sm
3	1.70	22.37	0.60	1.10	1.83	24.17	sm
4	1.64	21.58	0.78	0.86	1.10	14.53	m
<b>Total</b>	<b>7.60</b>	<b>100.00</b>	<b>2.66</b>	<b>4.94</b>	<b>7.57</b>	<b>100.00</b>	<b>--</b>
<b>Mean</b>	<b>1.90</b>	<b>--</b>	<b>0.67</b>	<b>1.23</b>	<b>1.89</b>	<b>--</b>	<b>--</b>
<b><math>\pm</math> SE</b>	<b><math>\pm</math> 0.16</b>	<b>--</b>	<b><math>\pm</math> 0.04</b>	<b><math>\pm</math> 0.17</b>	<b><math>\pm</math> 0.29</b>	<b>--</b>	<b>--</b>

*Subfamily: Asteroideae***Tribe: Inuleae****5 - *Anvillea garcini* (BURM. f.) DC.**

In this species a somatic number of  $2n=14$  and  $x=7$  were found. The karyotype consists of 5 pairs of metacentric chromosomes and 2 pairs of submetacentric chromosomes. The MCL is  $2.79 \pm 0.11 \mu\text{m}$ . The MAR is  $1.66 \pm 0.21$  and the TF% is 38.97. The karyotype asymmetry indices  $A_1$  and  $A_2$  are 0.36 and 0.11 respectively. The measurements of chromosomes are found in Table 5.

**Table 5. Measurements of somatic chromosomes of *Anvillea garcini* (BURM. f.) DC.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	3.36	17.23	1.44	1.92	1.33	11.44	m
2	2.94	15.08	1.16	1.78	1.53	13.16	m
3	2.80	14.36	1.14	1.66	1.46	12.55	m
4	2.72	13.95	1.22	1.50	1.23	10.58	m
5	2.72	13.95	1.00	1.72	1.72	14.79	sm
6	2.48	12.72	1.00	1.48	1.48	12.73	m
7	2.48	12.72	0.64	1.84	2.88	24.76	sm
<b>Total</b>	19.50	100.01	7.60	11.90	11.63	100.01	--
<b>Mean</b>	2.79	--	1.09	1.70	1.66	--	--
<b>± SE</b>	± 0.11	--	± 0.09	± 0.06	± 0.21	--	--

**6 - *Gymnarrhena micrantha* DESF.**

A somatic chromosome number of  $2n=20$  in 10 homologous pairs of 1M and 9m chromosomes was recorded in this species. The calculated MCL is  $1.48 \pm 0.07 \mu\text{m}$  and MAR is  $1.25 \pm 0.04$ . The TF% is 44.53, the  $A_1$  is 0.19 and  $A_2$  is 0.14. Chromosome measurements are found in Table 6.

**Table 6. Measurements of somatic chromosomes of *Gymnarrhena micrantha* DESF.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	1.80	12.15	0.76	1.04	1.37	10.98	m
2	1.70	11.47	0.72	0.98	1.36	10.90	m
3	1.60	10.80	0.74	0.86	1.16	9.29	m
4	1.56	10.53	0.74	0.82	1.11	8.89	m
5	1.56	10.53	0.64	0.92	1.44	11.54	m
6	1.50	10.12	0.68	0.82	1.21	9.70	m
7	1.40	9.45	0.60	0.80	1.33	10.66	m
8	1.36	9.18	0.68	0.68	1.00	8.01	M
9	1.26	8.50	0.56	0.70	1.25	10.02	m
10	1.08	7.29	0.48	0.60	1.25	10.02	m
<b>Total</b>	<b>14.82</b>	<b>100.02</b>	<b>6.60</b>	<b>8.22</b>	<b>12.48</b>	<b>100.01</b>	<b>--</b>
<b>Mean</b>	<b>1.48</b>	<b>--</b>	<b>0.66</b>	<b>0.82</b>	<b>1.25</b>	<b>--</b>	<b>--</b>
<b><math>\pm</math> SE</b>	<b><math>\pm</math> 0.07</b>	<b>--</b>	<b><math>\pm</math> 0.03</b>	<b><math>\pm</math> 0.04</b>	<b><math>\pm</math> 0.04</b>	<b>--</b>	<b>--</b>



### 7 - *Jasonia montana* (VAHL) BOTSCH.

The examined material of this species was found to be diploid with a somatic chromosome number of  $2n=16$  and a basic chromosome number of  $x=8$ . The karyotype of this species consists of 7 pairs of metacentric chromosomes and one pair of submetacentric chromosomes. The MCL is  $2.09 \pm 0.15 \mu\text{m}$ . The karyotype symmetry measures i.e. MAR ( $1.36 \pm 0.08$ ), the TF% (42.82),  $A_1$  (0.25) and the  $A_2$  (0.20) indicate a high degree of symmetry in the karyotype of this species. Measurements of chromosomes are found in Table 7.

**Table 7. Measurements of somatic chromosomes of *Jasonia montana* (VAHL) BOTSCH.**

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	2.90	17.34	1.28	1.62	1.27	11.67	m
2	2.40	14.35	1.08	1.32	1.22	11.21	m
3	2.24	13.40	1.06	1.18	1.11	10.20	m
4	2.08	12.44	0.74	1.34	1.81	16.64	sm
5	2.00	11.96	0.84	1.16	1.38	12.68	m
6	1.80	10.77	0.70	1.10	1.57	14.43	m
7	1.76	10.53	0.74	1.02	1.38	12.68	m
8	1.54	9.21	0.72	0.82	1.14	10.48	m
<b>Total</b>	16.72	100.00	7.16	9.56	10.88	99.99	--
<b>Mean</b>	2.09	--	0.90	1.19	1.36	--	--
<b>± SE</b>	± 0.15	--	± 0.08	± 0.08	± 0.08	--	--

## Tribe: Anthemideae

8 - *Anthemis melampodina* DEL.

This species has a somatic chromosome number of  $2n=18$  in 9 homologous pairs. The karyotype consists of 5m, 3sm and 1st chromosome pairs. This species has the longest chromosomes of the species here studied ( $MCL=3.85\pm 18\mu m$ ). The MAR is  $1.89\pm 0.27$ . The asymmetry of the karyotype of this species is also indicated by the values of TF% (37.08),  $A_1$  (0.40) and  $A_2$  (0.14). Detailed measurements are presented in Table 8.

Table 8. Measurements of somatic chromosomes of *Anthemis melampodina* DEL.

Chr. pair	Chr. length ( $\mu m$ )	Relative length	Short arm ( $\mu m$ )	Long arm ( $\mu m$ )	R. value	Relative R. value	Chromosome type
1	4.76	13.73	2.20	2.56	1.16	6.81	m
2	4.42	12.75	1.80	2.62	1.46	8.57	m
3	4.26	12.28	1.78	2.48	1.39	8.16	m
4	3.84	11.07	1.30	2.54	1.95	11.44	sm
5	3.68	10.61	1.66	2.02	1.22	7.16	m
6	3.58	10.32	0.80	2.78	3.48	20.42	st
7	3.54	10.21	0.92	2.62	2.85	16.73	sm
8	3.52	10.15	1.14	2.38	2.09	12.27	sm
9	3.08	8.88	1.26	1.82	1.44	8.45	m
<b>Total</b>	34.68	100.00	12.86	21.82	17.04	100.01	--
<b>Mean</b>	3.85		1.43	2.42	1.89		
<b><math>\pm</math> SE</b>	$\pm$ 0.18	--	$\pm$ 0.15	$\pm$ 0.10	$\pm$ 0.27	--	--

**9 - *A. microsperma* BOISS & KY.**

A somatic chromosome number of  $2n=18$  and  $x=9$  are also recorded in this species. The karyotype consists of 1M and 8m chromosome pairs. The chromosomes of this species are shorter than those of the previous species ( $MCL=2.14\pm 0.25\mu m$ ). The MAR are lower, but the TF% (43.97) is higher reflecting the presence of only metacentric chromosomes in the karyotype. The karyotype symmetry is also reflected by the indices of  $A_1$  and  $A_2$ , viz. 0.20 and 0.35 respectively. The detailed chromosome measurements are found in Table 9.

**Table 9. Measurements of somatic chromosomes of *Anthemis microsperma* BOISS. & KY.**

Chr. pair	Chr. length ( $\mu m$ )	Relative length	Short arm ( $\mu m$ )	Long arm ( $\mu m$ )	R. value	Relative R. value	Chromosome type
1	3.94	20.48	1.76	2.18	1.24	10.84	m
2	2.52	13.10	1.10	1.42	1.29	11.28	m
3	2.24	11.64	0.86	1.38	1.60	13.99	m
4	2.06	10.71	0.90	1.16	1.29	11.28	m
5	1.94	10.08	0.82	1.12	1.37	11.97	m
6	1.76	9.15	0.80	0.96	1.20	10.49	m
7	1.72	8.94	0.78	0.94	1.21	10.58	m
8	1.66	8.63	0.74	0.92	1.24	10.84	m
9	1.40	7.28	0.70	0.70	1.00	8.74	M
<b>Total</b>	19.24	100.01	8.46	10.78	11.44	100.01	--
<b>Mean</b> $\pm$ <b>SE</b>	2.14 $\pm$ 0.25	--	0.94 $\pm$ 0.11	1.20 $\pm$ 0.14	1.27 $\pm$ 0.05	--	--

*10 - Cotula anthemoides L.*

This species has a somatic chromosome number of  $2n=20$  in 10 homologous pairs. The karyotype is composed of 5m and 5sm chromosome pairs. The MCL is  $3.00 \pm 0.20$   $\mu\text{m}$ , MAR is  $1.62 \pm 0.10$  and the TF% is 37.95. The karyotype asymmetry is also indicated by  $A_1$  and  $A_2$  values (0.36 and 0.22 respectively). The chromosome measurements are presented in Table 10.

Table 10. Measurements of somatic chromosomes of *Cotula anthemoides L.*

Chr. pair	Chr. length ( $\mu\text{m}$ )	Relative length	Short arm ( $\mu\text{m}$ )	Long arm ( $\mu\text{m}$ )	R. value	Relative R. value	Chromosome type
1	4.14	13.78	1.32	2.82	2.14	13.19	sm
2	3.56	11.85	1.52	2.04	1.34	8.26	m
3	3.52	11.72	1.20	2.32	1.93	11.89	sm
4	3.44	11.45	1.18	2.26	1.92	11.83	sm
5	3.00	9.99	1.10	1.90	1.73	10.66	sm
6	2.78	9.25	1.00	1.78	1.78	10.97	sm
7	2.76	9.19	1.20	1.56	1.30	8.01	m
8	2.40	7.99	0.98	1.42	1.45	8.93	m
9	2.24	7.46	1.00	1.24	1.24	7.64	m
10	2.20	7.32	0.90	1.30	1.40	8.63	m
<b>Total</b>	30.04	100.00	11.40	18.64	16.23	100.01	--
<b>Mean</b>	3.00		0.14	1.86	1.62		
$\pm$	$\pm$	--	$\pm$	$\pm$	$\pm$	--	--
SE	0.20		0.06	0.16	0.10		

### Discussion

Of the 10 species studied of the Asteraceae from the Egyptian flora chromosome counts are observed for eight species for the first time. These new chromosome counts are recorded in; *Garhadiolus hedynois* ( $2n=12$ ), *Picris damascena* ( $2n=10$ ), *Thrinicia tripolitana* ( $2n=8$ ), *Gymnarrhena micrantha* ( $2n=20$ ), *Jasonia montana* ( $2n=16$ ), *Anthemis melampodina* ( $2n=18$ ), *A. microsperma* ( $2n=18$ ) and *Cotula anthemoides* ( $2n=20$ ).

The numbers recorded for the other two species, i.e.  $2n=54$  in *Carduus pycnocephalus* and  $2n=14$  in *Anvillea garcini*, are previously reported (FEDOROV 1969, GOLDBLATT & JOHNSON 1990, 1996 and GOLDBLATT 1985, GOLDBLATT & JOHNSON 1996, resp.).

In *Carduus pycnocephalus*  $2n=18, 32, 60$  and  $64$  are previously recorded (GOLDBLATT 1981-1988, GOLDBLATT & JOHNSON 1990-1996). For *Garhadiolus hedynois*  $2n=10$  was recorded in FEDOROV (1969). Also, in *Cotula anthemoides*  $2n=36$  is previously reported in FEDOROV (1969). Polyploidy is recorded only in *Carduus pycnocephalus* with  $2n=54$  and  $x=9$ .

Karyological studies were carried out for the first time for all the studied species. The karyotype analysis of the studied species shows that *Anthemis melampodina* has the longest chromosomes ( $MCL=3.85\pm 0.18\mu m$ ), whereas *Carduus pycnocephalus* has the shortest chromosomes ( $MCL=1.34\pm 0.14\mu m$ ). Four of the karyotypes studied are found to be symmetric with TF% above 40 and five with TF% above 35. The highest value of TF% (44.53) was found in *Gymnarrhena micrantha*, whereas the lowest (34.00) was found in *Garhadiolus hedynois*. The values of the TF% for the studied species thus support previous observations (HUZIWARA 1962, MEHRA 1977 and BADR et al. 1997) that the karyotype in the Asteraceae is symmetric. The calculated MAR and  $A_1$  values are generally low in all species which is in general agreement with the assumption that the karyotype in the family is symmetric.

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**Table 11. Localities and cytological features of the studied taxa. Collected by E. A. KAMEL; vouchers in Ain Shams University, Cairo, Egypt.**

**MCL=mean chromosome length**

**MAR=mean arm ratio**

**SE= standard error**

**TF %=total form percent**

**A<sub>1</sub>= intrachromosomal asymmetry index**

**A<sub>2</sub>=interchromosomal asymmetry index**

**m=metacentric chromosome**

**M=metacentric point chromosome**

**sm=submetacentric chromosome**

**st=subtelocentric chromosome**

**Asterisks indicate new chromosome counts.**



Sp.no.	Tribe	Species	Locality	Date of collection	2n	MCL. SE ( $\mu$ m)	MAR SE	TF%	A <sub>1</sub>	A <sub>2</sub>	Chr. Type			
											M	m	sm	
1	Carduaceae	<i>Carduus pycnocephalus</i> L.	Cairo - Alex. Agr. Road 160 km	4.4.97	54	1.34 ± 0.14	1.30 ± 0.02	43.64	0.23	0.31	-	9	-	-
2	Lactuceae	<i>Garhadiolus hedynois</i> (FISCH. et MEY.) JAUB. et SP. *	Bourg El-Arab	2.4.97	12	2.99 ± 0.23	2.07 ± 0.29	34.00	0.46	0.19	-	2	4	-
3	"	<i>Picris damascena</i> BOISS. et GAILL. *	Alex. - Matruh Road	31.3.97	10	2.67 ± 0.24	1.84 ± 0.08	35.53	0.45	0.20	-	1	4	-
4	"	<i>Thrinicia tripolitana</i> SCH.-BIP. *	Bourg El-Arab Marakia	2.4.97	8	1.90 ± 0.16	1.89 ± 0.29	35.00	0.42	0.17	-	1	3	-
5	Inuleae	<i>Anvillea garcini</i> (BURM. f.) DC.	Cairo - Suez Road	24.3.97	14	2.79 ± 0.11	1.66 ± 0.21	38.97	0.36	0.11	-	5	2	-
6	"	<i>Gymnarrhena micrantha</i> DESF. *	Alex. - Matruh Road	31.3.97	20	1.48 ± 0.07	1.25 ± 0.04	44.53	0.19	0.14	1	9	-	-
7	"	<i>Jasonia montana</i> (VAHL) BOTSCH. *	Wadi Al-Arbein-San Cathreen-Sinai	8.4.95	16	2.09 ± 0.15	1.36 ± 0.08	42.82	0.25	0.20	-	7	1	-
8	Anthemideae	<i>Anthemis melampodina</i> DEL. *	Cairo - Suez Road	24.3.97	18	3.85 ± 0.18	1.89 ± 0.27	37.08	0.40	0.14	-	5	3	1
9	"	<i>Anthemis microsperma</i> BOISS. & KY. *	Cairo - Alex. desert Road	2.4.97	18	2.14 ± 0.25	1.27 ± 0.05	43.97	0.20	0.35	1	8	-	-
10	"	<i>Cottula anthemoides</i> L. *	Cairo - Alex. desert Road/Bourg El-Arab	2.4.97	20	3.00 ± 0.20	1.62 ± 0.10	37.95	0.36	0.22	-	5	5	-

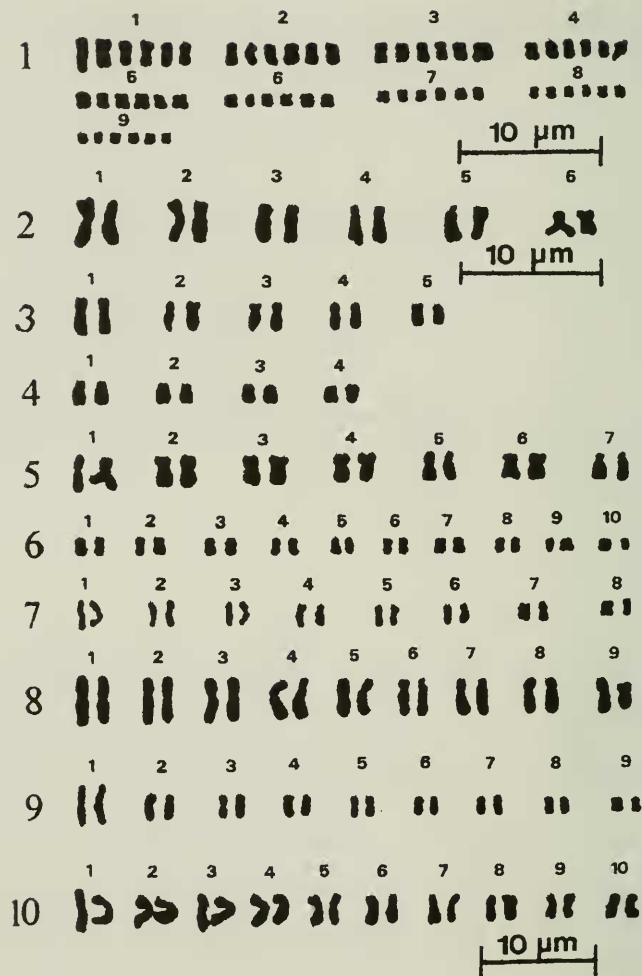


Fig. 1. Karyotype of the studied species of the Asteraceae.

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|----------------------------------|----------------------------------|
| (1) <i>Carduus pycnocephalus</i> | (2) <i>Garhadiolus hedynois</i>  |
| (3) <i>Picris damascena</i>      | (4) <i>Thrinicia tripolitana</i> |
| (5) <i>Anvillea garcini</i>      | (6) <i>Gymnarrhena micrantha</i> |
| (7) <i>Jasonia montana</i>       | (8) <i>Anthemis melampodina</i>  |
| (9) <i>A. microsperma</i>        | (10) <i>Cotula anthemoides</i>   |